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BRANCH OF RESEARCH AND ANALYSIS

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R & A No. 1800

ELECTRIC POWER IN YUGOSLAVIA

Basic information on power resources, generating stations, transmission and distribution systems, and production and consumption of electric power in Yugoslavia.

31 October 1943

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SUMMARY

Electricity is of little real importance to the primarily agricultural economy of Yugoslavia, except in the northwest, the Belgrade area, and the Split industrial region. Lack of capital and markets hindered pre-war exploitation of potentially rich power resources. Plants are small: of the 713 stations making up Yugoslavia's 1936 installed capacity of 467,435 kw., only seven, accounting for a total of 201,250 kw., were over 10,000 kw. in size. No grid network exists, except in fragmentary form in the northwest, and to some extent in the Belgrade area. Principal producing and consuming areas are in the industrialized north and west. In 1936, about 80 percent of the total production of 795.5 million kwh. was consumed by industries; this percentage may be higher at present.

A. Introduction

Yugoslavia has relatively undeveloped electric power facilities, judged by United States or western European standards, despite the fact that some parts of the country pioneered in adopting electricity. Some plants date back as far as 1890. The early rapid development was not sustained, however. As a result, the present pattern of electrification is sketchy.

In general, electricity is of real importance in Yugoslavia only in the northwest, in the Belgrade area, and in the Split industrial region. The national economy is primarily agricultural and not vitally dependent on electric power. The only important exceptions are the chemical industry (completely dependent on electricity), extraction of minerals (partly dependent), and a rather poorly developed steel industry (not dependent in the main). Before the war, lack of industry and other markets, as well as scarcity of foreign and domestic capital, hampered exploitation of the wealth of coal and water-power available.

In 1932, only 973 of the 6,575 towns and villages in Yugoslavia were supplied with electricity. The distribution of electricity in relation to the size of the community served is shown in Table 1.

Table 1

YUGOSLAVIA, DISTRIBUTION OF ELECTRIC POWER SUPPLY BY SIZE OF URBAN COMMUNITY (1932)

Size of Community (population)	Total No. of Communities	No. of communities supplied	Percent of communities supplies
Over 20,000	21	21	100.0
10,000-19,999	74	48	64.9
5,000- 9,999	302	117	38.8
2,000- 4,999	1,270	229	18.1
Under 2,000	4,907	557	11.0

In 1934, only 28.5 percent of the population was served by electricity. In 1935, total annual consumption of electric power for domestic use was 5 kwh. per capita, as compared with 11 kwh. in the U.S.S.R. and 500 kwh. in Switzerland.

Except in the extreme northwest and in the Belgrade area, the power system consists of a large number of small isolated plants, with almost no interconnection. The northwest (former Slovenia and Croatia), including the cities of Ljubljana, Zagreb, and Maribor, is the principal industrial area of the country, with coal, iron, and steel undertakings. Electricity requirements are supplied by a large number of small plants, together with Fala, one of the most important power stations in the country.

B. Power Plants

1. General. At the end of 1936, Yugoslavia had 713 power plants over 10 kw. in size with a total installed capacity of 467,435 kw.[1] Of these, 251 were steam and 172 were hydroelectric. Only seven plants were over 10,000 kw. in size.

Table 2.

YUGOSLAVIA, POWER PLANTS AND INSTALLED CAPACITY (1936)

Type	No.	Percent of total	Installed Capacity (kw.)	Percent of total
Steam	251	32.20	182,152	38.97
Diesel	114	15.99	15,089	3.23
Gas	56	7.86	4,827	1.03
Hydro	172	24.12	161,409	34.53
Mixed	120	16.83	103,958	22.24
Total	713	100.00	467,435	100.00

See Tables 3 and 4 at end of report for further details.

The seven largest plants accounted for 201,250 kw., or 43.05 percent of the total. The four largest steam plants (Trbovlje, Zagreb, and the two Belgrade plants) accounted for 78,250 kw., or 42.96 percent of total installed steam power. The three largest hydroelectric plants (Fala, Gubavika, Manojlovac) accounted for 123,000 kw., or 76.20 percent of total installed hydroelectric power. In Yugoslavia, private plants are fully as important as those for public supply. Almost every important industry owns its power source, instead of buying from public utility companies. Some of these plants in turn supply municipalities.

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[1] Since then, installed capacity is estimated by one source to have risen by about 100,000 to 150,000 kw., but detailed confirmation is not available (see C., Projects, p. 13-14).

Table 5.
YUGOSLAVIA, POWER PLANTS BY TYPE OF OWNERSHIP (1936)

Banovina	Number of plants				
	Public	Private	State	Mixed	Total
Dravska	84	142	3	18	247
Drinska	13	26	7	5	51
Dunavska	53	1	1	20	75
Moravska	33	20	7	5	65
Primorska	18	3	2	4	27
Savska	32	71	6	19	128
Vardarska	18	2	3	6	29
Vrbaska	8	3	3	14	28
Zetska	21	3	4	1	29
Belgrade area	4	26	4	--	34
Total 1936	284	297	40	92	713

Most plants are quite old. Some stations, still running after 40 years of service, give good service, but the economy of their operation is doubtful. Generating equipment usually consist of a larger number of small units; only in the newer stations are a smaller number of larger units installed. Much of the equipment is of German manufacture.

2. Hydroelectric Plants. Potential water power of Yugoslavia has been estimated at from 3 million hp. at low water to 9 million hp. at high water. Only about 5 percent has been exploited, mainly because of lack of capital and markets. The greatest utilization of water power has been in the west, particularly in the industrialized Dravska and the Primorska banovinas, which together accounted for 83.84 percent of total hydroelectric installed capacity in 1937.

Table 6.
YUGOSLAVIA, POTENTIAL WATER POWER

Banovina	Potential water power (hp.)	Percent of potential
Dravska	260,000	7.43
Savska	405,000	11.57
Vrbaska	407,000	11.63
Primorska	148,000	4.23
Drinska	424,000	12.11
Zetska	332,000	9.49
Moravska	696,000	19.89
Vardarska	361,000	10.31
Dunavska	467,000	13.34
Total	3,500,000	100.00

Yugoslav rivers differ considerably in their hydrology. Alpine rivers are characterized by two high and two low water seasons. High water occurs in spring, when the snow melts, and during autumn rains, usually beginning in October. Low water occurs during the winter freeze and the July and August droughts. Bosnian rivers show similar features, escept for a less pronounced winter dry season. Rivers of the Adriatic basin have no winter low, but many of them become nearly dry during the summer. The volume of flow of rivers in southeastern Yugoslavia shows little seasonal variation.

Hydroelectric plants are generally medium or low head. The largest and most important stations serve private industry: Gubavika (carbide and cement), Fala (carbide), and Manojlovac (carbide).

Table 7

YUGOSLAVIA, HYDROELECTRIC PLANTS IN ORDER OF INSTALLED CAPACITY

Name	Banovina	Began Operations	Installed Capacity (kw.)
GUBAVIKA (KRALJEVEC)	Primorska	1908	67,200
CRIKVENICA (TRIBALJ)	Savska	Under construction	40,000-70,000
FALA	Dravska	1919	35,000-37,500
MANOJLOVAC (POLJANE)	Primorska	1906	20,800
JAJCE	Vrbaska	1900	8,000
TRESKA (SANTA ANDREAS)	Vardaska	1938	5,280
SIBENIK (JARUGA)	Primorska	1904	5,200
KARLOVAC (OSALJ)	Savska	1908	3,600
FUZINE	Dravska	1896/1923	2,475
JELICA (OVCAR KABLAR)*	Drinska	1921	2,400
ZIROVNICA	Dravska	1915	2,250
TRZIC (SV.ANA)	Dravska	1903	2,200
TETOVO	Vardarska	1926	2,200
KRANJ	Dravska	1924	1,790
SKRAD (SKARDA; ZELENI VIR)	Savska	1922	1,020
BROD PRI VIZMARIJH	Dravska	1908	1,020
RUPE (ROSKI SLAP)	Primorska	1910	1,000

*Doubtful. May be steam; see under Table 8, Yugoslavia, Thermal Plants in Order of Installed Capacity.

3. Thermal Plants. Thermal power in Yugoslavia is produced by steam, Diesel, and gas installations. Gas and Diesel plants are small and unimportant. The only steam plants of importance are the combined Belgrade municipal station and the Zagreb municipal station, both of which are small by western European standards. There are only four plants over 10,000 kw. in size: the new (30,000 kw.) and the old (12,000 kw.) Belgrade plants, the Zagreb plant (25,000 kw.), and the station at the Trbovlje coal mines (11,250 kw.). About 75 percent of the coal consumed in these stations before the war was low-grade local brown coal, of which the country has a considerable amount.

Table 8
YUGOSLAVIA, THERMAL PLANTS IN ORDER OF INSTALLED CAPACITY

Name	Banovina	Began Operations	Installed Capacity (kw.)
TRBOVLJE	Dravska	Under construction 1941	50,000
BELGRADE (New)	Belgrade area	1932	30,000
ZAGREB	Savska	1907	25,000
BELGRADE (Old)	Belgrade area	1892	12,000
TRBOVLJE	Dravska	1914	11,250
NOVI SAD	Dunavska	1910	8,925
LJUBLJANA	Dravska	1898	6,900
CRVENKA	Dunavska	1924	6,270
MAKIS	Belgrade area	1925	6,150
SUBOTICA	Dunavska	1896/1931	5,085
RTANJ-RUDNIK	Moravska	1929	4,480
MITROVICA	Zetska	1930	3,830
NOVI VRBAS	Dunavska	1908	3,654
KREKA (TUZLA)	Drinska	1906	3,370
ALEKSINAC	Moravska	1919	3,200
KASTEL SUCURAC	Primorska	1919	3,125
MOSTAR	Primorska	1921	3,100
VELENJE	Dravska	1925	2,870

Table 8 (cont'd)
YUGOSLAVIA, THERMAL PLANTS IN ORDER OF INSTALLED CAPACITY

Name	Banovina	Began Operations	Installed Capacity (kw.)
SENJSKI RUDNIK	Moravska	1930	2,500
LITIJA	Dravska	1886	2,300
BROD	Savska	1922	2,200
OSIJEK	Savska	1926	2,200
KAKANJ	Drinska	1908	2,140
BEOCIN	Dunavska	1896/1932	2,000
BOR	Moravska	1906	2,000
VRDNIK	Dunavska	1911	1,900
VARES	Drinska	1899/1928	1,875
ZENICA	Drinska	1888	1,870
VELIKI BECKEREK (PETROVGRAD)	Dunavska	1911	1,549
ZAGREB	Savska	1923	1,505
CUKARICA	Belgrade area	1912	1,500
ZEMUN	Belgrade area	1901	1,480
DUBROVNIK II	Zetska	1900	1,440
VELIKA KIKINDA	Dunavska	1906	1,425
LJUBIJA	Vrbaska	1917	1,375
SREMSKA MITROVICA	Drinska	1913	1,260
VRSAC	Dunavska	1897/1931	1,260

Table 8 (cont'd)

YUGOSLAVIA, THERMAL PLANTS IN ORDER OF INSTALLED CAPACITY

Name	Banovina	Began Operations	Installed Capacity (kw.)
CUPRIJA	Moravska	1912	1,220
ZENICA	Drinska	----	1,170
KRANJ	Dravska	1929	1,120
KOCEVJE	Dravska	1919	1,115
VUKOVAR	Savska	1932	1,100
CACAK*	Drinska	1931	1,036
PANCEVO	Belgrade Area	1925	1,020
KRAGUJEVAC	Dunavska	Post-1932	1,000
VEVCE	Dravska	1896	1,000
PRISTINA	Vardarska	----	Over 500

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*Doubtful. May be hydroelectric; see under Table 7, Yugoslavia, Hydroelectric Plants in Order of Installed Capacity.

4. Mixed Plants. The only mixed plant of any size is the Jesenice aggregation (hydro and steam) in the extreme northwest of Yugoslavia, about 40 miles from Ljubljana. Its load is mainly industrial.

Table 9.

YUGOSLAVIA, MIXED PLANTS IN ORDER OF INSTALLED CAPACITY

Name	Banovina	Began Operations	Installed Capacity (kw.)
JESENICE	Dravska	----	10,600
SARAJEVO	Drinska	1895/1926-30	3,400
SOLIN-MAJDAN	Primorska	1909	3,340
SUSAK	Savska	1920	3,000
NIS	Moravska	----	2,800
LESKOVAC	Vardarska	1902	2,755
DUGA RESA	Savska	----	2,300
MEZICA	Dravska	1900/1926	2,055

C. Projects

Yugoslavia has many power projects either planned or under construction, but how far they have developed under wartime conditions cannot at present be ascertained.

1. Generating Plants.

a. Crikvenica (Tribalj), a 40,000 kw. underground hydroelectric project on the Dalmation coast is under construction. The station is supposed to connect with Zagreb, possibly also with Fala, and with the new steam plant in the vicinity of Brod (see below) at 100 kv. Completion, due in 1943, is not now expected before 1944.

b. A steam plant of 35,000 hp. capacity, burning inferior local lignite, is projected somewhere near Brod or Nova Gradiska. It is to be joined to Crikvenica at 100 kv. The State Electrification Administration (DEP) of Croatia has placed orders for machinery and construction materials; and the plant is scheduled for completion by the middle of 1945.

c. A 50,000 kw. extension of the Trbovlje steam plant was said to be under construction in 1941 to link up with the proposed 100 kv. system Zagreb-Fala, but definite information as to its progress is not available.

d. Various extensions and new plants have been proposed for the industrial area served by Jesenice, but information as to whether these projects are being carried out is not available.

e. At the end of 1941, plans were approved for the construction of a new hydroelectric plant at Velica Gorica, 12 miles southeast of Zagreb. Confirmation of actual construction is not available.

f. Plants at Ohridsko Lake and Prespansko Lake, in the extreme south, both over 100,000 kw. and using heads of around 600 to 700 feet, were projected in 1939. It is not clear how power from these large plants would be utilized over the long distance involved.

g. A steam plant at Mostar, burning coal residue mined in the district, is scheduled to supply Dubrovnik, which now has only a Diesel plant.

h. Terni (Italian industrial concern) has requested permission to build a hydroelectric station in the Viapoco (Vipano) Valley on the former Italo-Yugoslav frontier. The station will help to supply Ljubljana.

i. The Rumanian press reports that Rumania, Bulgaria, and Serbia have agreed to build a hydroelectric plant whose output would be divided among all three countries, in the neighborhood of the Iron Gate of the Danube. A German commission was to study construction possibilities.

2. Transmission Lines. In addition to the transmission lines projected above, and a 100-kv. line from Zagreb to Reichenberg (see under Transmission System), the DEP has built lines from Ivanic Grad to Banova Jaruga and Zagreb and from Zapresic to Savska Marof, both at 10 kv. A line from Ilova to Novska was to have been completed in 1943. As part of the policy of developing Dalmatia as a supplementary industrial region, the Italians were constructing a 30 kv. power line in the Zadar region. Construction progress is unknown. In Serbia, under German military government, the Neues Wiener Tageblatt reports an appropriation of 5 million dinars for electrification.

D. Transmission System (See maps on North Yugoslavia: Electricity and South Yugoslavia: Electricity).

Yugoslavia has no grid network except in fragmentary form in the northwest, and to some extent in the Belgrade area. Most plants are small, supplying a limited territory over short transmission lines of low voltage. Thus the partition of the country since its occupation by the Axis has not created any great supply problems. The only part of the distribution system of major importance is that extending from the Fala hydroelectric plant. Very few high-tension substations exist, except in connection with the 80 kv. systems of Fala and Gubavika. In general, transformers are of small capacity.

Cross-frontier connections are of little importance. There is a small connection at Susak (opposite Fiume), of purely local significance. In 1933 the industrial area north of Ljubljana was said to take some power from the Austrian grid through Graz, and this connection may still be in operation. A connection between Zagreb and Reichenberg built for 100 kv. but operating at 30 kv., was scheduled to go into service in the middle of 1943. The Germans have declared that by this arrangement, electric power will be furnished for all of northeastern Croatia. The main purpose, however, appears to be to ship current north to the Reich, especially in winter, when power from the Alps is at a minimum.

E. Production and Consumption

Yugoslavia is self-sufficient in electric power. Production is on the increase: in 1937, power output was 912,575,000 kwh., a 12.8 percent gain over 1936 and a 30.8 percent gain over 1935. Output for 1942 is estimated at a little over one billion kwh.

Table 10.

YUGOSLAVIA, ELECTRIC POWER PRODUCTION (1936)
(in thousands of kwh.)

Banovina	Production	Percent of total
Dravska	239,652	30.12
Drinska	38,064	4.78
Dunavska	61,308	7.71
Moravska	52,424	6.59
Primorska	167,289	21.03
Savska	89,133	11.20
Vardarska	11,715	1.47
Vrbaska	46,503	5.85
Zetska	25,911	3.26
Belgrade area	63,581	7.99
Total 1936	795,580	100.00
Total 1935	631,395	100.00

Principal producing and consuming areas are located in the industrialized north and west (former Austro-Hungarian territory). In 1936, Dravska and Primorska banovinas produced 406,941,000 kwh. (51.15 percent of total Yugoslav production) and consumed 365,399,000 kwh. (51.03 percent of total Yugoslav consumption). In 1936, about 80 percent of total consumption was for industrial uses. This percentage may since have been increased, but probably not to a significant extent.

Table 11.

YUGOSLAVIA, ELECTRIC POWER CONSUMPTION*

(1936) (in thousands of kwh.)

Banovina	Plant's own use	Public lighting	Private lighting	Motors	Industrial Use	Total	Percent of Total
Dravska	201	2,638	12,382	124,242	80,954	220,417	30.78
Drinska	3,713	1,436	4,194	19,510	2,906	31,759	4.43
Dunavska	5,147	4,213	8,696	33,776	2,612	54,444	7.60
Moravska	6,678	1,784	3,614	33,880	699	46,656	6.52
Primorska	9,338	385	12,839	24,810	97,611	144,982	20.25
Savska	8,657	4,458	12,510	53,175	1,672	80,471	11.24
Vardarska	382	2,209	2,882	3,533	1,065	10,070	1.41
Vrbaska	503	737	577	10,070	30,687	42,574	5.95
Zetska	1,208	738	1,238	20,990	868	25,042	3.50
Belgrade area	4,574	5,501	10,421	39,089	---	59,586	8.32
Total 1936	40,401	24,098	69,353	363,077	219,074	716,004	100.00
Total 1935	27,360	20,658	76,372	276,408	165,888	566,686	100.00

*Difference between production and consumption represents in the main transmission losses.

Annual per capita consumption is low. Highest average consumption is in the urban Belgrade area, the industrialized Dravska, and the Primorska Banovinas. Lowest average consumption is in Vardarska.

Table 12.

YUGOSLAVIA, KWH. CONSUMPTION PER INHABITANT (1936)

Banovina	Population (1931)	Total Power Consumption	Consumption per Inhabitant, kwh.
Dravska	1,144,298	220,417,000	192.62
Drinska	1,534,739	31,759,000	20.69
Dunavska	2,387,295	54,444,000	22.80
Moravska	1,435,584	46,656,000	32.49
Primorska	901,660	144,982,000	160.79
Savska	2,704,383	80,471,000	29.75
Vardarska	1,574,243	10,070,000	6.39
Vrbaska	1,037,382	42,574,000	41.03
Zetska	925,516	25,042,000	27.05
Belgrade area	288,938	59,586,000	206.22
Total	13,934,038	716,004,000	51.38

Yugoslavia, in common with other European countries, is experiencing a power shortage due to drought and to difficulties in producing, transporting, and storing coal. These conditions have necessitated the introduction of local rationing schemes, mostly affecting domestic consumption. Beginning in the winter of 1941-42, the coal shortage in Serbia necessitated rationing of electricity in Belgrade. By autumn of 1942, Croatia also was experiencing difficulties which resulted in: power rationing, punishments for violations, appeals to consumers to further limit use of current, fixing of working hours of industrial establishments, and suspension of deliveries of new electrical apparatus of all kinds. The situation remains serious, as is indicated by the further curtailment on August 24, 1943, of industrial consumption in Zagreb. Domestic consumers have been repeatedly warned that wastage of current will be punished by imprisonment or heavy fine. No electric appliances may be used and lights must be used only when necessary.

F. Local Electricity Supplies

Since 1930 low-tension electricity supplies have been standardized as 3-phase AC, 50 cycles, 220/380 volts. The few important exceptions, some of which may now have been changed, are

Banja Luka (Vrbaska) -- 120/210 volts AC
Bjelovar (Savska) -- 220 volts DC
Cetinje (Zetska) -- 110/190 volts AC
Dubrovnik (Zetska) -- 125/220 volts AC
Mostar (Primorska) -- 125/220 volts AC
Nis (Moravska) -- 150 volts AC
Omis (Primorska) -- 180/330 volts AC
Sisak (Savska) -- 220 volts DC
Subotica (Dunavska) -- 42 cycles, 127/220 volts AC
Sibenik (Primorska) -- 42 cycles, 110/220 volts AC
Velika Kikinda (Dunavska) -- 150 volts AC
Vrsac (Dunavska) -- 42 cycles, 105 volts AC

Table 3. YUGOSLAVIA: ELECTRIC POWER PLANTS (1936)[a]

Banovina	Steam		Diesel		Gas		Hydro		Mixed		Total			
	No.	Kw.	No.	Kw.	No.	Kw.	No.	Kw.	No.	Kw.	No.	Percent	Kw.	Percent
Dravska	71	30,366	15	763	-	--	126	51,162	35	29,400	247	34.64	111,691	23.89
Drinska	32	14,584	3	594	6	342	6	674	4	8,019	51	7.15	24,213	5.18
Dunavska	15	18,322	12	2,190	19	2,449	-	---	29	24,313	75	10.52	47,274	10.11
Moravska	32	19,089	7	758	10	892	7	2,525	9	15,372	65	9.11	38,636	8.27
Primorska	1	2,500	15	934	2	46	6	94,156	3	7,765	27	3.79	105,401	22.55
Savska	53	51,487	27	2,915	14	906	9	1,309	25	11,849	128	17.95	68,466	14.65
Vardarska	5	178	5	1,698	3	74	8	2,601	8	3,266	29	4.07	7,817	1.67
Vrbaska	16	4,346	3	184	1	102	5	8,090	3	1,079	28	3.93	13,801	2.95
Zetska	6	7,162	16	2,825	1	16	5	892	1	115	29	4.07	11,010	2.36
Belgrade area	20	34,118	11	2,229	-	-	-	---	3	2,780	34	4.77	39,127	8.37
Total	251	182,152	114	15,089	56	4,827	172	161,409	120	103,958	713	100.00	467,435	100.00

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a Excluding plants below 10-kilowatt installed capacity.

Table 4. YUGOSLAVIA: POWER PLANTS OVER 1,000 KW. IN SIZE

S = steam D = Diesel H = hydro

Name	Location	Type	Installed capacity (kw.)	Remarks
Aleksinac	20 mi. NW of Nis; Moravska.	S	3,200	Supplies town; also partly industrial. Began operations 1919. Two sets; 4 kv. May be plant belonging to Rudnici Ugja u Aleksinacu (brown coal concessions), with an installed capacity of 4040 kw.
Banja Luka	In or near Banja Luka; Vrbaska.	?H	1,050	Owned by Bosnian Co. for Lumber Exploitation and Sawmill Operation. May also supply agricultural projects.
	In Belgrade.	?S	1,050	Began operations around 1923. Owned by Textilfabrik Kosta Ilic Soehne AG.
Belgrade (old)	In Belgrade, close to Danube and below mouth of Sava, probably adjoining site of new Belgrade plant.	S	12,000	Began operations 1892; owned by street railways. Eight machine sets. System: 600 V., 2 kv., and 6 kv., 42 cycles. Probably now standby; may even be dismantled.
Belgrade (new)	44° 50' N 20° 28' E. In Belgrade, close to Danube and below mouth of Sava.	S	30,000	Largest steam plant in Yugoslavia. 1938 output 45 mill. kwh. Owned by city; built in 1932 to replace old plant (see above). Single concrete chimney 280 ft. high. Condition

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				after Belgrade bombing unknown, but report says replacement orders given to BBC within a few days. Owing to coal shortage plant reported in May 1942 working only 30 percent of capacity; both street car and domestic supplies rationed. Plant consists of a main building, an administration building, a 250-T unloading crane and bridge, and barge canal. Iron and brick construction; foundations 15 m. deep, because of soil porosity. Plant located 100 m. from river bank. Two tracks connect with railway line Klanica-Belgrade; dead-end barge canal connects with the Danube. System: 6.6 kv.; 50 cycles; controlled frequency. Fuel: Serbian lignite, brought by rail, high in moisture, sulphur, and clinker. Trifail (Styrian) coal, 12 percent ash, from Zagreb area, brought by barge. Ample open coal storage space (140 x 58 m.). Boilers: eight, 36,000 lbs./hr.; 500 lbs./sq. in.; 800° F; Sulzer. Water-softening plant and pre-heated feed water. Turboalternators:

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				3 of 6,000 kw. each, BBC (1932), at 3,000 rpm.; one of 12,000 kw., BBC 1938, at ?3,000 rpm.; one 400-kw. house set. Condensing water from Danube. Transformers: 3 of 600 kva. each; 6.6 kv./380/220 v BBC; for local use. Main distribution: 4 feeders to town at 6 kv. Two substations each containing three 2500-kva., 6.3/3.1-kv. transformers, each substation linked to plant by two cables, 3 x 185 sq. mm. cross section. Distribution network in 1934 was around 15 mi. of 6.3- and 3.1-kv. cables. Supplies, probably at 6 kv., to Pancevo and Zemun. Street cars fed through 2 rotary converter subs and 4 rectifier subs, total capacity 5,300 kw. Street car supply probably 600 v. DC; local supplies 220/380 v. AC.
Beocin	On Danube, 45 mi. NW of Belgrade; Dunavska	S	2,000-4,125	Owned by Beocin Cement Mfg. Co. Four sets; 5 kv.; 1896/1932. Linked with Novi Sad at 33 kv., double circuit, six wire. May also connect with Vrdnik.
Bor	44° 05' N 22° 07' E E of Bor village, 50 mi. N of Nis; Moravska	D & S	2,000	Reported 14,000 kw. 1940. Sole source of power for mines. Coal supplies come down Danube on barges; moved from river by

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				railway. Began operations 1906. Seven generating sets; 230 v. DC.
Brod	Halfway between Zagreb and Belgrade on main Belgrade-Zagreb railway; Savska	S	2,200-3,000	Began operations 1926. Owned by First Yugoslav Wagon, Machine and Bridge Works, Ltd.; supplies city also. 2 sets. System: 3-ph. AC, 50 cycles, 3,000/220/380 v.
Brod pri Vizmarijh	5 mi. NW of Ljubljana; Dravska	H	1,020	Began operations 1908; helps to supply Ljubljana. Water from the Sava. Two sets (Francis); 6.5 kv.
Cacak	60 mi. S of Belgrade; Drinska	S	1,036	Built 1931; supplies paper industry. Two sets; 380 v.
Crikvenica (Tribalj; Vinodol; Nova Gradiska)	Around 5 mi. from Crikvenica, 60 mi. S of Ljubljana; Savska	H	40,000-70,000	Underground. Dam at Fuzine. Head 2,300 ft. Under construction by DEP (State Electrical Supply Co.); due for completion in 1943, but difficulties with cement supply, tools and excavators, sabotage, and labor shortage have delayed completion, probably until 1944. To supply Zagreb and NW Croatia, as well as proposed electrification of Zagreb-Fiume railway.
Crvenka	70 mi. NW of Belgrade; Dunavska	S	6,270	Owned by Crvenka Sugar Factory; built in 1924. Seven (?four)

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				generating sets; 3.1 kv. Supplies town at 10 kv.
Cukarica	At Belgrade	S	1,500	Owned by Government Sugar Factory; built 1912. Four generating sets; 500 v.
Cuprija	50 mi. NW of Nis; Moravska	S	1,220	Sugar. Five generating sets; 220 volts. Built 1912. Linked with Senjski Rudnik.
Dubrovnik II	At S end of port of Gruz (Gravosa), about $\frac{1}{2}$ mi. NW of the walled city.	D	1,440	Supplies town and probably also street cars; generated $1\frac{1}{2}$ mill. kwh. in 1937. Built 1900. Originally coal-burning; 370 kw. capacity; later converted to Diesel. Four generating sets (3 CKD; 1 SSW Berlin); 3-ph., 50-cycle AC at 6.3 kv.
Duga Resa	At Duga Resa, 35 mi. SW of Zagreb; Savska	S & H	2,300	Owned by Duga Resa National Cotton Yarn and Weaving Co. Two stations, with hydro plant (head 19.7 ft.) on Mreznica River. Four generating sets; 550 v., 40 cycles, and 6 kv., 50 cycles. Linked with Karlovac at 20 kv.
Fala	46° 34' N 15° 28' E. Nine mi. W of Maribor, upstream on the Drava	H	35,000-37,500	Built by Steiermärkische Co. (Graz) 1913-1918. Fully developed. Output 172 mill. kwh. in 1938; maximum possible is 200 mill. kwh. Main consumers

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				in 1936 were Rusce electrochemical works (50%), Trbovlje (Trifail) coal field, and towns (15%). System: 10 kv.; 3-ph., 50 cycles. Head 45 ft.; water supply from the Drava. Plant forms an extension of the adjustable weir; length, including plant, is 600 ft. Turbogenerators: five of 4200 kw.; 150 rpm.; 4 by Escher Wyss; one by A.C.E.C.; 5 alternators by BBC (pre-1925). One of 7,000 kw.; horizontal double-Francis type by A.C.E.C./BBC (1928). One of 7,000 kw. reported installed 1937. Transformers: three of 9,000 kva., 10/80 kv., BBC, oil-cooled, indoor; two of 1600 kva., 10/35 kv., air-cooled, indoor; 700 kva. of house transformers, 10 kv./500/380 v. Extensive local network in 1932. Main distribution at 10, 35, and 80 kv. Local to Maribor and district and to Rusce carbide works at 10 kv. Long distance: one 80-kv. to Laško around 43 mi. in length; one 35-kv. along the Drava to Ormoz and district. One 35-kv. through Maribor, thence S to Konujica, (may have been stepped up to 80 kv.).

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
Fuzine	Just SE of Ljubljana; Dravska	H	2,475	Paper. Might be Fuzine near Susak (Dravska). Three generating plants; 6 kv.; 1896/1923. May be two plants supplying paper factories at Vevce and Janezija.
Jajce	70 mi. NE of Split, on left bank of Vrbas River N of village of Jajce; Vrbaska	H	8,000-10,000	System: 160/180 v., 3 ph., 50/60 cycles; possibly DC also. Owned by Bosnia Electric Power Co. Head: around 250 ft. Water supply: (a) from Vrbas River by dam or weir at Jajca Falls; (b) from Pliva Lake, W of Jajce. Turboalternators: eight 1,000-kw. sets known. Supplies Jajce village. Main function is to supply Jajce ferro-silicon works, (short distance to W of power plant; so near no transformers required).
Jelica (Ovcar Kablar)	?Cacak; Drinska	H	2,400	Supplies Cacak, lighting only. May be Cacak steam plant.
Jesenice	In extreme NW of country, about 40 mi. from Ljubljana (Dravska)	H & S	10,600	Load is mainly industrial. Extensions proposed in 1939 to meet increased steel requirements. System: 500 v., 2 kv., 10 kv.; 3-ph., 50 cycles. There appear to be 4 plants in group: (1) Jesenice -- 2 old steam sets totalling ca. 3,000 kw., at 5 kv. and 500 v.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				Exact location not determined, but probably in steel plant. (2) Vintgar--a small hydro plant, 300-900 kw., at 5 kv., on Bohinjska Savica River below Vintgar falls. (3) Zavrsnica-Zasip--takes water from Vintgar by canal to surge tank. Two pipes to two generating sets, possibly around 3,000 kw. each, at 5 or 10 kv. (4) Zirovnica--water from a stone and concrete dam on tributary of Sava Dolinka River, by canal, surge tower and 2 penstocks to 3 Pelton generating sets. Size doubtful; may total 5,000 kw. Built 1914. Generates at 11 kv., 50 cycles. In 1932 two 1250-kw. sets and an extensive local distribution at 10-kv. existed. Connected with Kranj and Ljubljana, and with Sv. Ana.
Kakanj	30 mi. NW of Sarajevo; Drinska	S	2,140	Built 1908; supplies mines. Three generating sets (one steam engine and two steam turbines, burning coal from Gries colliery in Czechoslovakia) Generates AC 50 cycles at 550 v. Linked with Zenica and Vares-Majdan.
Karlovac (See Osalj)				
Kastel Sucurac	Probably in Solin, on bay between Split and Kastel Sucurac; Primorska	S	3,125	Owned by Split Portland Cement Co.; built 1919. Two sets; generation at 525 v. Can take power from Split if necessary.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
Kocevje	35 mi. SE of Ljubljana; Dravska	S	1,115	Part industrial. Built 1919. Two sets; generation at 3 kv. There may possibly be a small reserve Diesel plant in town.
Kragujevac	60 mi. SE of Belgrade; Dunavska	S	1,000	No details; probably post-1932. Possibly also a small Diesel plant (360 kw.), built in 1928.
Kraljevac (Gubavika)	43° 26' N. 16° 54' E. 10 mi. E of Omis, 15 mi. SE of Split, on Cetina River near junction with Kraljevac River, close to village of Zadvorje (Duare). 160-ft. bluffs. Primorska.	H	67,200	Largest plant in Yugoslavia; built around 1908; elevation 200 ft. Belongs to La Dalmatienne; main consumers are carbide and cement industries at Almissa (Dugirat, Jasenice), and area between power plant and Split. System: 3.8 kv.; 3-phase; 50 cycles. Water supply: from Cetina River at the deep gorge above Gubavika waterfall. Head 360.9 ft. From a 200-yd. weir in river a 200-yd. canal leads to a 1,300-yd. tunnel ending in surge chamber. From here, 4-7-ft. diam. pipes drop to plant. Plant building: concrete with flat roof. Windows covered with heavy wire netting. Turboalternators: two of 12,800 kw. each, horizontal double-Francis type by Ganz, installed 1912, 375 rpm.; two of 20,800 kw. each,

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				double-Francis type, installed 1931, 375 rpm. Transformers (in-door substation): two of 16,000 kva., water-cooled, 3.8/56 kv.; two of 42,000 kva., 3.8/80 kv. Main long-distance distribution: one double line on steel towers, 20 mi. long, to Almissa and Split, designed for 80 kv. and operating at either or both 56 kv. and 80 kv. Almissa transformer equipment: two of 16,000 kva., 52/15 kv.; two of 42,000 kva; 80/15 kv. Split transformer equipment (at Dujmovaca, just N of Split, near cement works): two of 2,700 kva., 50/10 kv. (50-kv. gear outdoors). Five feeders supply the 14 local substations of Split. Power generation depends on water supply. In winter, when water is plentiful, all four sets run and lines operate at 80 kv.; in summer, only 1,912 sets run, and lines operate at 56 kv.
Kranj	15 mi. NW of Ljubljana Dravska	S	1,120	Partly textiles. Built 1929. One set; generation may be at 10 kv.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
Kranj	15 mi. NW of Ljubljana; Dravska	H	1,790	Built 1924. Four sets; generation at 3 kv. Linked with Medvode at 35 kv.
Kreka (Tuzla)	50 mi. N of Sarajevo; Drinska	S	3,370	Burns lignite from Kreka mines. Supplies mines and Kreka community. Built 1905. Generates 3-ph., AC, 42 cycles, 3,000/300/150 v.
Leskovac	20 mi S of Nis; Vardarska	S-H	2,755	Built 1902. Linked with Vucje hydro plant (located around 10 mi. SSW of Leskovac on a tributary of the Suzna Morava; 3 generating sets of 900 kw. total installed capacity) at 22 kv. Three sets, generating 3-ph. AC at 6,000 (?3,000) v.
Litija	**At Litija, 15 mi. E of Ljubljana; Dravska**	S	2,300	Owned by Yugoslav Textile Works Mautner, Ltd. built 1886. Four generating sets; 380 v. Linked with Ljubljana at 20 kv.
Ljubljana	In Ljubljana; Dravska	S-D	6,900	Output 24 mill. kwh. in 1936; 50 percent to lighting. System 6.3 kv.; 3 ph., 50 cycles; and 320/360 v. DC. Plant dates from around 1898; belongs to street railways. Generating plant: 4 steam engine sets totalling 1,200 kw., installed

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				before 1905, generating DC and used as standby. Two 400-kw., 6-cylinder Diesel sets, 6.3 kv., installed 1925, used as standby. One 4,000-kw., Skoda-Siemens Schuckert turboalternator, 6.3 kv., installed 1930. Brunner boilers, for the 4,000-kw. set, installed 1930. Converting plant: one 300-kw. motor-generator set by BBC, converting from AC to DC, to take place of old DC sets, installed around 1925. Main distribution: linked with Jesenice, Celje, Kocevje, Litija, Zagradev, and Velenje. Whole area covered by a low-power net, of which details vague (1936 distribution network reported to be 500 mi. of cable from 3 to 60 kv.)
Ljubija	About 6 mi. SW of Prijedor, nr. Banja Luka, 70 mi. SE of Zagreb; Vrbaska	S	1,375	Owned by State iron and steel trust; supplies open-pit iron ore mine. Built 1917. Two sets; generation at 3 kv.
Makis	10 mi. SW of Belgrade	S	6,150	Built 1925. Two sets; generation at 6 kv. May be standby to enlarged Vreoci station (2 steam turbines, each 3,500 kw.). Cable under the Sava. Some

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				30 kv. distribution, and possible 60 kv. link with enlarged Vreoci steam plant.
Manojlovac (Poljane)	44° 01' N 16° 02' E. About 8½ mi. WSW of Knin on Krka River, at upper Krk falls, 40 mi NW of Split; Primorska	H	20,800	Belongs to La Dalmatienne. Built 1906. Plant is difficult target from air, located in ravine between 700-ft. cliffs. System: 30 kv.; 3-ph., 42 cycles. Head 330 ft. Water supply: from Krka River, through four pipes dropping from a surge tank to plant. Turboalternators: four of 4,300 kw. each, horizontal Francis type by Ganz: 420 rpm. Transformers: no definite information, but probably none, since power generated at such a high figure. Bulk of power used by "Cernica" carbide plant of La Dalmatienne at Sibenik, 22 mi. away. (one 30-kv. double line on wooden poles). Current here reduced to 50 v. for furnace use by 12 single-phase transformers.
Maribor	At Maribor; Dravska	Unknown	1,125	Owned by J. Hutter and Co. (textiles) Generates 3 ph. AC.
Mitrovica	42° 55' N 20° 51' E. At Zvecan, 1.9 mi. NW of Mitrovica, 60 mi. SW of Nis; Zetska	S	6,500- 7,000	Serves Tropca ore-dressing and smelting works and Stantrg lead-zinc mines. Babcock and Wilson boilers using forced draught,

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				with superheaters and mechanical grate-stokers, designed to burn local lignite, crushed before use. Equipment (1932) was 3 steam turbines geared to alternators (2,250 kw. 1,250 kw., and 330 kw.) generating 3-ph., 50 cycle AC at 3.3 kv. Between 1932 and 1939 a fourth alternator of ca. 3,000 kw. was installed. An unconfirmed report lists an increase in capacity to 14,000 kw. Current used at generation voltage for large motors; stepped down to 380 v. for small motors and 220 v. for lighting. Transmission to Stantrg mines at 35 kv., with step-down transformers at mine. In 1938, the installation of a 500-hp. standby Diesel generator set at Stantrg was nearly completed.
Mezica (Žerjav)	30 mi. NE of Ljubljana; Dravska	S-H-D	2,055	Owned by Central European Mines, Ltd. (lead and zinc); built 1900/1926. Four separate plants (Pustnik Poljana, Topola, Žerjav). Largest (Žerjav) has 3 generating sets; 3.3 kv. May be linked to Velenje Sv. Ana and Kranj at 35 kv.
Mostar	Probably NW of the town, 70 mi. E of Split; Primorska	S	3,100	Supplies Mostar mines, airport, town, and industry; built 1921. Two sets; generation at 5 kv.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				May be also a small Diesel plant (340 kw.) in town.
Mladenovac	At Mladenovac; Dunavska	Unknown	1,462	Owned by Bag and Cloth Mfg. Co. (jute bags).
Nis	In and around Nis, near Bulgarian frontier; Moravska	H-S-D	2,800	System: 7.5/8.3 kv.; 3-ph.; 50 cycles. Four separate plants: (1) Sv. Petka--hydro, exact location not determined, but about 5-10 mi. E of Sićevo, containing three 250-kw. sets generating 3-ph., 50 cycles AC at 8.3 kv. Another report lists installed capacity as about 1300 kw. Plant seems to be linked with Sićevo at 25 kv. Built 1909. (2) Crveni Krst--steam, probably located in city of Nis, built 1929. One steam turbo set generating at 7.5 kv. (3) Sićevo--hydro; on Nišava R., about 10 mi. E of Nis. Built 1931. Two 440-kw. sets; generation at 8.3 kv. Linked with Nis at 25 kv. through Niška Banja. (4) A Diesel plant, location not determined, built 1912, containing one standby set of 250 kw. Town network extends about 10 mi. (1930); probably linked with Prokuplje at unknown voltage. Street cars use 800 v. DC; other

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				local supplies are at 150 v. AC.
Novi Sad	40 mi. NW of Belgrade; Dunavska	S-D	8,925	25,661,000 kwh. reported generated in 1940, of which 11,214,850 kwh. went to Beocin Cement Co. Burns Vrdnik coal. Capacity controlled by bailer installations (around 5,000 kw.). Supplies city of Novi-Sad; also Futog, Gložan, Cib Petrovac, Kulpin, Jarek, Temerin, Petrovaradin, Karlovci, Kamenica-Paragovo. Built 1910. Six sets, generating 3-ph. AC, 50 cycles, at 3,000 v. Main distribution at 10 kv. Street cars use 550 v. DC. Main transmission lines: One 33-kv. line, concrete poles, to Zabalj; one 30-kv. line, 2 circuits, 6 wires, to Beocin cement plant. Possibly also linked with Vrdnik.
Novi Vrbas	65 mi. NW of Belgrade; Dunavska	S	3,654	Owned by Hemp Factory "Bachka", Ltd.; supplies sugar and textiles industries, as well as communities of Novi Vrbas, Kula, Stari Vrbas. Built 1908. Burns flax residue. Six generating sets (AEG) producing current at 3.3 kv.
Osalj (Karlovac)	30 mi. SW of Zagreb, close to Osalj, on right bank of Kupa River a few miles above Karlovac; Savska	H	3,600	Another report gives installed capacity as 10,875 kw. A third gives ca. 15,000 kw. Output: 10 mill. kwh. in 1936.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				System: 5 kv. 3-ph., 50 cycles. Built 1908; belongs to town of Karlovac. Supplies Karlovac, Osalj, Duga Resa, Metlika and possibly Crnomelj via 20 kv. lines; exports winter surplus power to Zagreb. Karlovac also has a standby Diesel plant (700 kw. in 1938). Low-head plant (26 ft.). Water from Kupa River, by a weir. Turboalternators: three 1,200-kw. Francis sets by Voith-SSW, installed 1908. Transformers: probably 5/20 kv. for transfer of power to Karlovac. In Karlovac indoor substation are two 3,000-kva., 20/30/5 kv. transformers. The 5-kv. winding is for supply to town. Main distribution: local to Karlovac substation at 20 kv.; long distance to Zagreb from Karlovac at 30 kv.
Osijek	100 mi. NW of Belgrade; Savska	S	2,200	Generated 5 mill. kwh. in 1936. Plant built 1926. Two sets, producing 3-phase, AC, 50 cycles, at 3,000 v, 600 kw. used by street cars at 600 v.
Pancevo	10 mi. E of Belgrade	D	1,020	Built 1925. Four sets, generating at 3.1 kv. 15-kv. network.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
Pristina	50 mi. N of Skoplje; Vardarska	S	Over 500	Quite small in 1932; reported increased since then.
Rtanj-Rudnik	At Baljevac, between Paracin and Zaječar, 30 mi. N of Nis; Moravska	S	4,480	Supplies coal mines. Built 1929. Two sets; generation at 6 kv.
Rupe (Roski Slap)	Probably on Krka R., about 15 mi. NW of Drnis, 30 mi. NW of Split; Primorska	H	1,000	Built 1910. Two sets; generation at 3.3 kv.
Sarajevo	100 mi. E of Split; Drinska	S-H	Ca. 3,400	Built 1895; modernized 1926-1930. Output $7\frac{1}{2}$ mill. kwh. in 1929. System: 3 kv.; 3-ph., 50 cycles. Boilers: 4 water tube; 400 lbs./sq in.; 700° F; installed 1928; mechanical stokers. Generating plant: 4 old steam sets totalling around 2,000 hp., installed between 1895 and 1911, some still operating in 1930. Two small hydro plants, totalling about 900 hp., installed around 1924, and working off the town's water supply, at Dudin Hrid, with a head of 1500 ft. One 2,000 kva. Skoda steam turbo; 3,000 rpm., installed 1928. One 750 kw. synchronous motor-generator, 3 kv. 600, 300, and 220 v. DC Street car supply is 200 v. DC. Distribution: by cable at 3 kv. to 25 substations in town. 110/220 v. DC available in center of town; rest of town gets 110/190 and 220/380 v. AC. L.t. network is all overhead.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
Senjski Rudnik	50 mi. NW of Nis; Moravska	S	2,500	Supplies mines. Built 1930. Two sets; generation at 5.2 kv. May be linked at 10 kv. to Cuprija.
Šibenik (Jaruga; Skadinski Buk)	35 mi. NW of Split; on Krka River near Skradin; Primorska	H	5,200	Supplies town and carbide industry; also probably the nearby Lozovac aluminum plant. Built 1904. Head 80 ft. Two sets in 1939, generating AC, ?2 phase, 42 cycles, at 15,000 v.
Skrad (Skarda)	45 mi. S of Ljubljana, on Zelini Vir River; Savska	H	1,020	One report gives capacity as 5,000 kw. Head 184 ft. Supplies surrounding villages and lumber industries in the Gorski Kotar. Built 1922. One set, generating AC, 3-phase, at 5 kv.
Solin-Majdan	Just outside Split; Primorska	S-H	3,340	Owned by cement company. Built 1909. Reported to feed Split dockyard. Four sets; generation at 3.1 kv.
Sremska Mitrovica	40 mi. W of Belgrade; Drinska	G-D	1,260	Built 1913. Three sets; generation at 2.1 kv. Supplies town. 15 kv. network.
Subotica	100 mi. NW of Belgrade	S	5,085	Built 1896; modernized 1931. Boilers: 2 Babcock-Wilson, 235 sq. m. heating surface, operating pressure 12.5 atm. up until 350° superheat; 2 Schlick-Nicholson, vertically baffled, 209 sq. m. heating surface, operating pressure 13.5 atm. up until 350° superheat, with economizer. Six generating sets, producing AC 3-ph., 42 cycles, at 2,000 v. Supplies city. Street cars: 500 kw. of 500 v. DC.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
Susak	50 mi. S of Ljubljana; Savska	S-H	3,000	Owned by Smith Menier paper works. Built 1920. Head 36 ft. Produced 1.5 mill. kwh. in 1938. Seven sets; 550 v.; 42 cycles. May be linked with Fiume.
Sv. Ana	Probably at Trzic, 30 mi. NW of Ljubljana; Dravska	H	2,200	Probably the plant of the Glanzman and Gassner Cotton Yarn and Weaving Co. at Trzic; may also be two stations. Two sets; 6.3 kv. Plant built 1903. May be linked with Kranj, Mezica, and Velenje at 35 kv.
Tetovo	30 mi. W of Skoplje; 1½ mi. from Tetovo; Vardarska	H	2,200	Owned by Tetovsko Industrijsko a.d. Output around 1 mill. kwh. per year. Supplies Tetovo and Skoplje. Built 1926. Head 230 ft. Two sets, generating AC, 3-ph. 50 cycles, at 3,150 v. 35 kv. line to Skoplje where two 1,000 kva. 35/6 kv. transformers are installed.
Trbovlje (Trifail)	30 mi. E of Ljubljana; just E of Rajhenburg village; Dravska	S	11,250	Brown coal; owned by largest private coal mining co. in Yugoslavia. Built 1914. Generation at 3 kv. Takes power from Fala in winter at 35 kv.
Trbovlje (Trifail)	30 mi. E of Ljubljana; Dravska	S	50,000	Under construction 1941 for coal company. Two sets. Planned to link with Zagreb at 100 kv.

Table 4 (continued)

Name	Location	Type	Installed capacity (kw.)	Remarks
Treska (Santa Andreas)	10 mi. SW of Skoplje, at mouth of narrow Treska gorge close to Santa Andreas monastery. Precise location reported at end of motor road from Skoplje; Vardarska	H	5,280	Owned by Skoplje; built 1936-38 to supply city and district, supplementing Tetovo plant. A small 1,050 kva. Diesel plant in Skoplje is standby. Current reduced from 30 kv. to 6 kv. at Skoplje to suit local network. System: 6 kv.; 3-phase; 50 cycles. Head 57/80 ft. Water supply from the Treska by dam 100 ft. high built on limestone base. Dam: reinforced concrete arch, variable radius, constant angle (Jorgensen style); upstream face covered with extra heavy reinforced concrete slab. Overflow channel on right bank of impounded water. Power plant: downstream from dam on left bank of river. Turboalternators: three 1,400 kw. vertical-shaft Francis sets by Voith/AEG, 500 rpm., built for head of 24.5 m. and flow of 6.5 cbm./ sec. Transformers: 3 converters (?transformers), 6/30 kv. Main distribution: one 30 kv. line, 8 mi. long, on steel poles to Skoplje substation.
Vares-Majdan	At Vares, 25 mi. NW of Sarajevo; Drinska	S	1,875	Supplies Vares iron works. Output around 2 mill. kwh. per year. Built 1899/1928. Two sets, generating AC, 42 cycles, 3,100 v. and 230 v. Connection with Zenica via Kakanj.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
Velenje	At brown coal mine, Slovenji Gradec district, near railway station Skale, 35 mi. NE of Ljubljana; Dravska	S	2,870	Reported increased to 7,250 kw. Burns brown coal. Built 1925. Three sets, generating current at 5.2 kv. Reported supplying power to Ljubljana over a 60-kv. line via Crnuce and Trojane. May be linked to Mezica, Sv. Ana and Kranj at 35 kv. Town of Velenje also has a small industrial plant.
Veliki Beckerek (Petrovgrad)	At Veliki Petrovgrad, 40 mi. N of Belgrade; Dunavska	S	1,549-2,325	Owned by Veliki Beckerek Sugar Mfg. Co. Built 1911. 1940 output: 2,652,763 kwh. Also supplies city. Four sets, generating 3-ph., AC, 42 cycles, 3150 v.
Velika Kikinda	70 mi. N of Belgrade; Dunavska	S	1,425	Supplies city. Built 1906. Four sets, generating 3-ph., AC, 50 cycles at 3,000 v. Distribution at 10 kv.
Vevce	50 mi. S of Ljubljana; Dravska	S	1,000	Owned by paper mills; built 1896. One set, generating at 6 kv. Standby; mills normally take power from Fuzine.
Vrdnik	In Irig district near Vrdnik railway station, 40 mi. NW of Belgrade; Dunavska	S	1,900	Owned by mines; supplies them as well as towns of Vrdnik, Irig, and neighborhood. Built 1911. Two sets,

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				generating at 3 kv. Distribution at 10 kv. May connect with Novi Sad.
Vrsac	45 mi. NE of Belgrade; Dunavska	S-D	1,260	Built 1897; additions 1931. 3 sets, generating AC, 42 cycles at 3,000 v.
Vukovar	At Barovo, 80 mi. NW of Belgrade; Savska	S	1,100	Belongs to Bata Co; built 1932. Supplies town also. One set, generating at 3 kv.
Zagreb	In Zagreb; Savska	S	1,505	Owned by Zagreb Paper Mfg. Co. Built 1923. Another report lists installed capacity as 3,225 kw., consisting of 3 steam turbines, 3800 hp., and a reserve steam engine of 500 hp.
Zagreb	45° 48' N 15° 57' E. In W part of Zagreb, around 1,100 ft. S of W railroad yards.	S	25,000	Reported as 36,000 kw. in 1940. 1941 output over 60 mill. kwh. System: 5 kv., 3-ph., 50 cycles. Pre-war fuel supply was imported (around 150,000 t.p.a.) now probably local lignite. Boilers: Skoda. Turboalternators: 3 pre-1914 sets totalling 3,200 kw., now standby. One 5,000-kw. Skoda-SSW set, installed 1924. One 10,000-kw. Skoda-SSW set, installed 1928. Possible additional sets. Transformers:

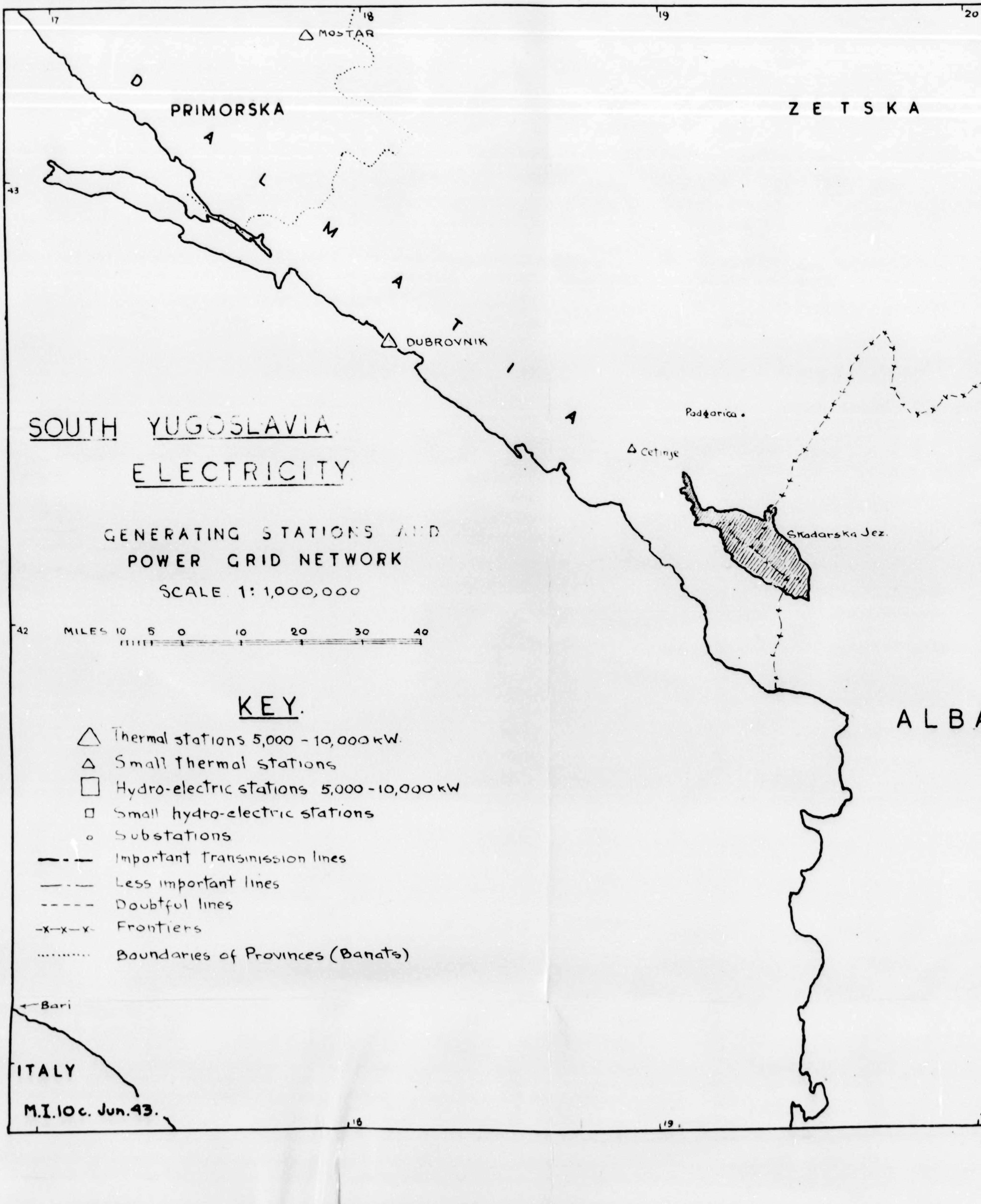
Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
				two of 3,000 kva., 5, 30 kv., for Karlovac line. These may be 1,500 kva., or there may be two 1,500 kva. transformers in addition. Main local distribution at 5 kv. and 220/380 v. AC. Long-distance distribution: one 60-kv. (still running at 30 kv. in 1941) to Karlovac from special indoor substation 200 yards away; one 5-kv. double line to Podsused (Savabrücke); one 30-kv. line E to Dugo Selo with possible extensions. Built 1907. Street cars installed 1910; now fed through Siemens converters at 625 v., DC. Linked since 1930 with Osalj and Duga Resa hydro plants, with Zagreb acting as supplement and peak-load. This line carries 30 kv. to Karlovac; 20 kv. from there. Another line serves area southeast of Zagreb at 20 kv. Scheme to link Zagreb with Crikvenica and Fala at 100 kv. 1941 network around 658 mi. Over 75,000 consumers. Mainly lighting load, although power furnished for local industries (chemical, textile) and airport.

Table 4 (continued).

Name	Location	Type	Installed capacity (kw.)	Remarks
Zemun	44° 50' N 20° 25' E. In NE quarter of Zemun near the Danube, 5 mi. NW of Belgrade	S	1,480	Owned by Electric, Traffic, and Industrial Ltd., Zemun. Supplies town; furnishes power for local aircraft components factories and airport. Built 1901. Three sets, generating AC, 3-ph., 50 cycles, 2.1 kv.
Zenica	At Zenica, 35 mi. NW of Sarajevo; Drinska	S	1,170	Another report lists capacity as 2175 kw. Supplies steel works. Two sets; 540 v.
Zenica	35 mi. NW of Sarajevo; Drinska	S	1,870	Built 1888. Supplies brown coal mine controlled by State steel trust. Three sets, generating 3.1 kv. Reported to be 13,000 kw. in 1940; may have been extended for steel works. One or both of Zenica plants linked with Kakanj and Vares-Majdan.
Zirovnica	30 mi. NW of Ljubljana; Dravska. On Zavrsnica River, a tributary of the Sava.	H	2,250	Probably part of Jesenice (see above). Two sources report ownership by KDE (Banovinal power system). Dam impounds large artificial lake. Head 525 ft. Water drops 345 ft. through tunnel and steel pipe-line to plant, on left bank of Sava River. Machine sets: 2 Pelton wheels directly coupled to 2 generators of 1500 hp. each. Capacity could be increased.

Due to its large size, the following document has been filmed in segments. The order of the segments is as follows: left to right, top to bottom.


17
18
19
20
43
42
MOSTAR
PRIMORSKA
D A L M A T I A
ZETSKA
DUBROVNIK
Podgorica
Cetinje
Skadarska Jez.
ALBA
Bari
ITALY
18
19

SOUTH YUGOSLAVIA
ELECTRICITY

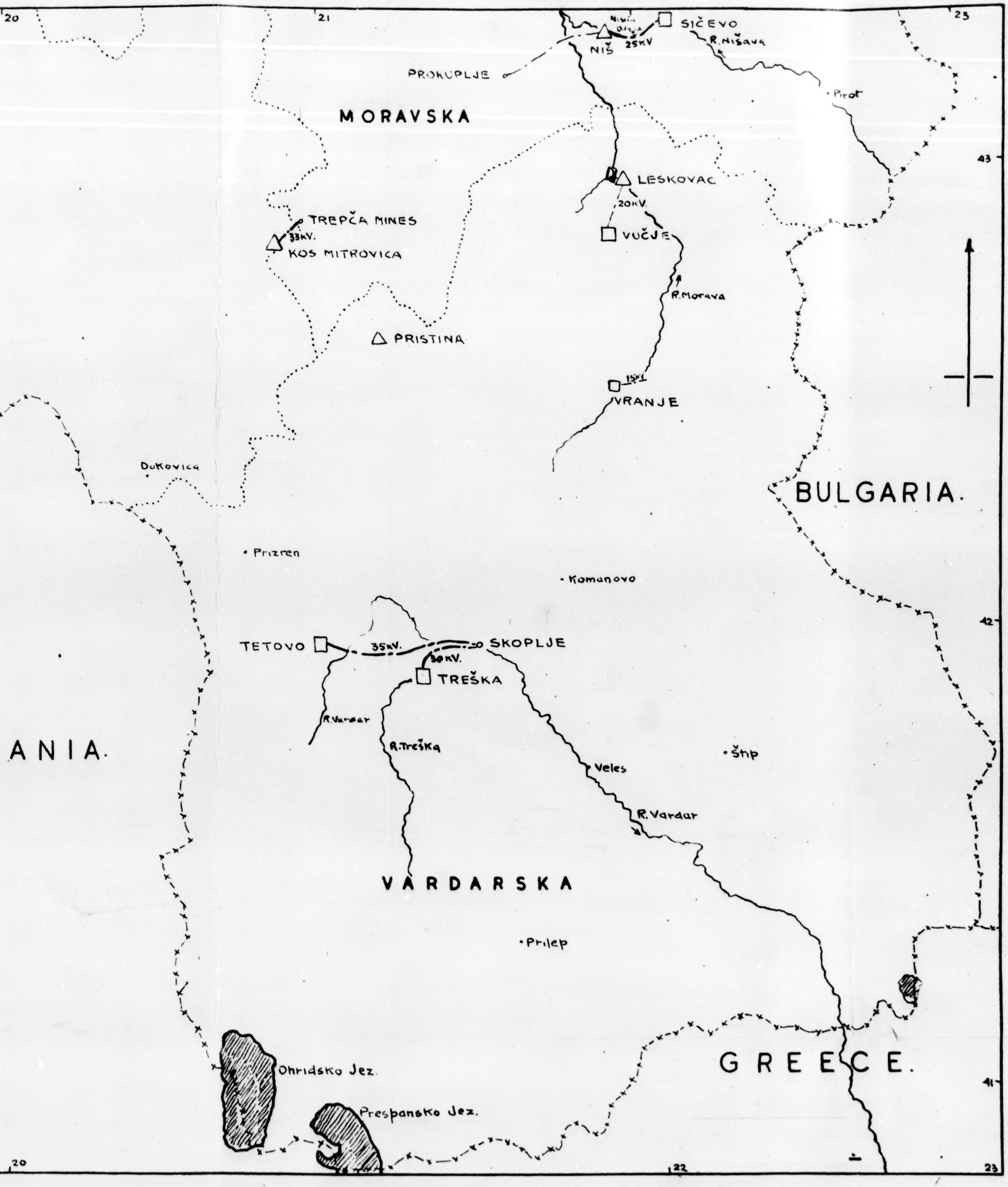
GENERATING STATIONS AND
POWER GRID NETWORK
SCALE 1: 1,000,000

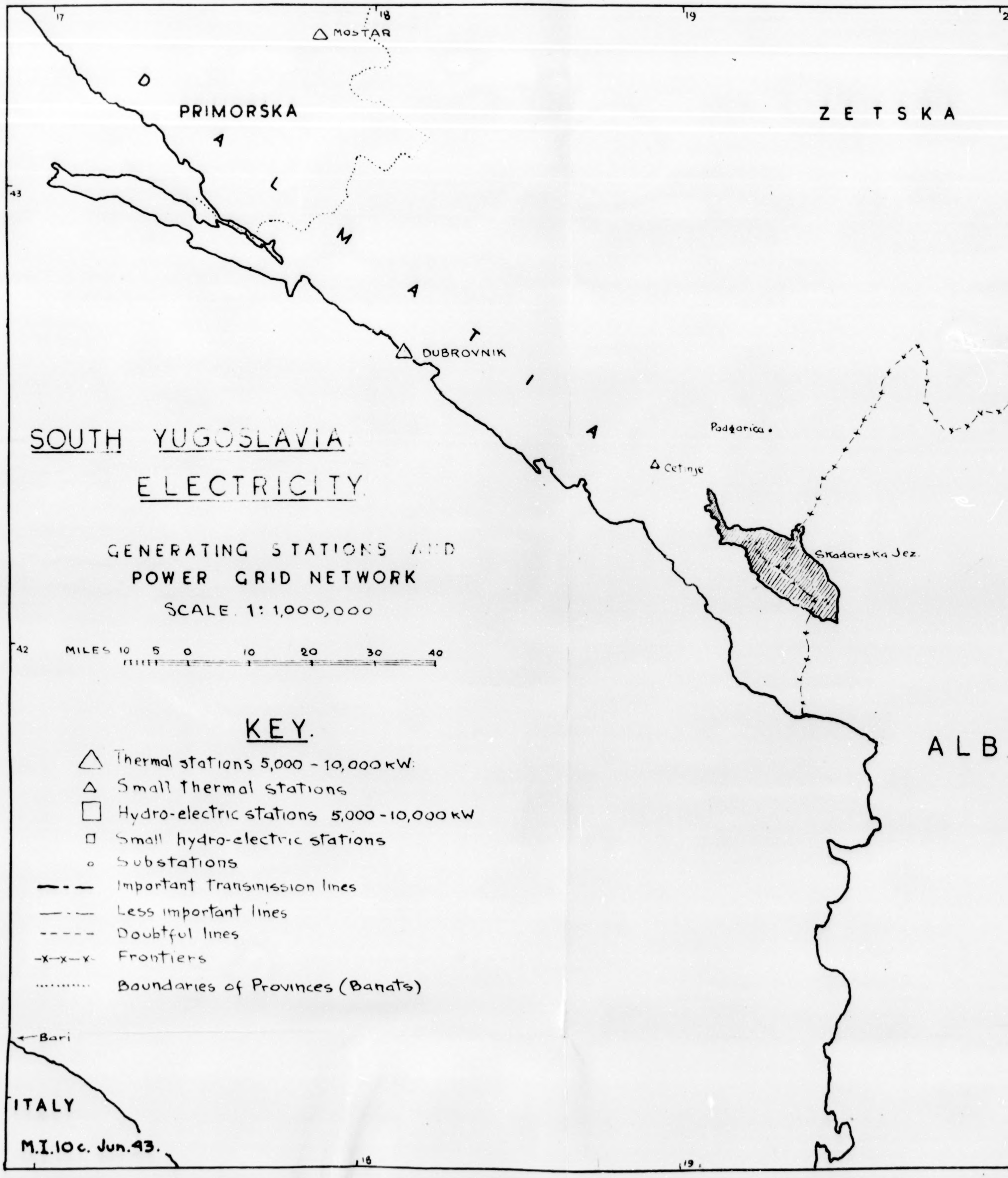
MILES 10 5 0 10 20 30 40

KEY.

- △ Thermal stations 5,000 - 10,000 kW.
- △ Small thermal stations
- ☐ Hydro-electric stations 5,000 - 10,000 kW
- ☐ Small hydro-electric stations
- ○ Substations
- ━ - ━ Important transmission lines
- — - — Less important lines
- - - - - Doubtful lines
- -x-x-x- Frontiers
- .... Boundaries of Provinces (Banats)

M.I.10c. Jun.43.


20
21
22
23
43
42
41
SIČEVO
NIŠ
25KV
R. Nišava
PROKUPLJE
Pirot
MORAVSKA
LESKOVAC
20KV.
VUČJE
TREPČA MINES
33KV.
KOS MITROVICA
R. Morava
PRISTINA
15KV
VRANJE
Đakovica
BULGARIA.
Prizren
Komanovo
TETOVO
35KV.
SKOPLJE
30KV.
TREŠKA
R. Vardar
R. Treška
ANIA.
Štip
Veles
R. Vardar
VARDARSKA
Prilep
GREECE.
Ohridsko Jez.
Prespansko Jez.


17
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MOSTAR
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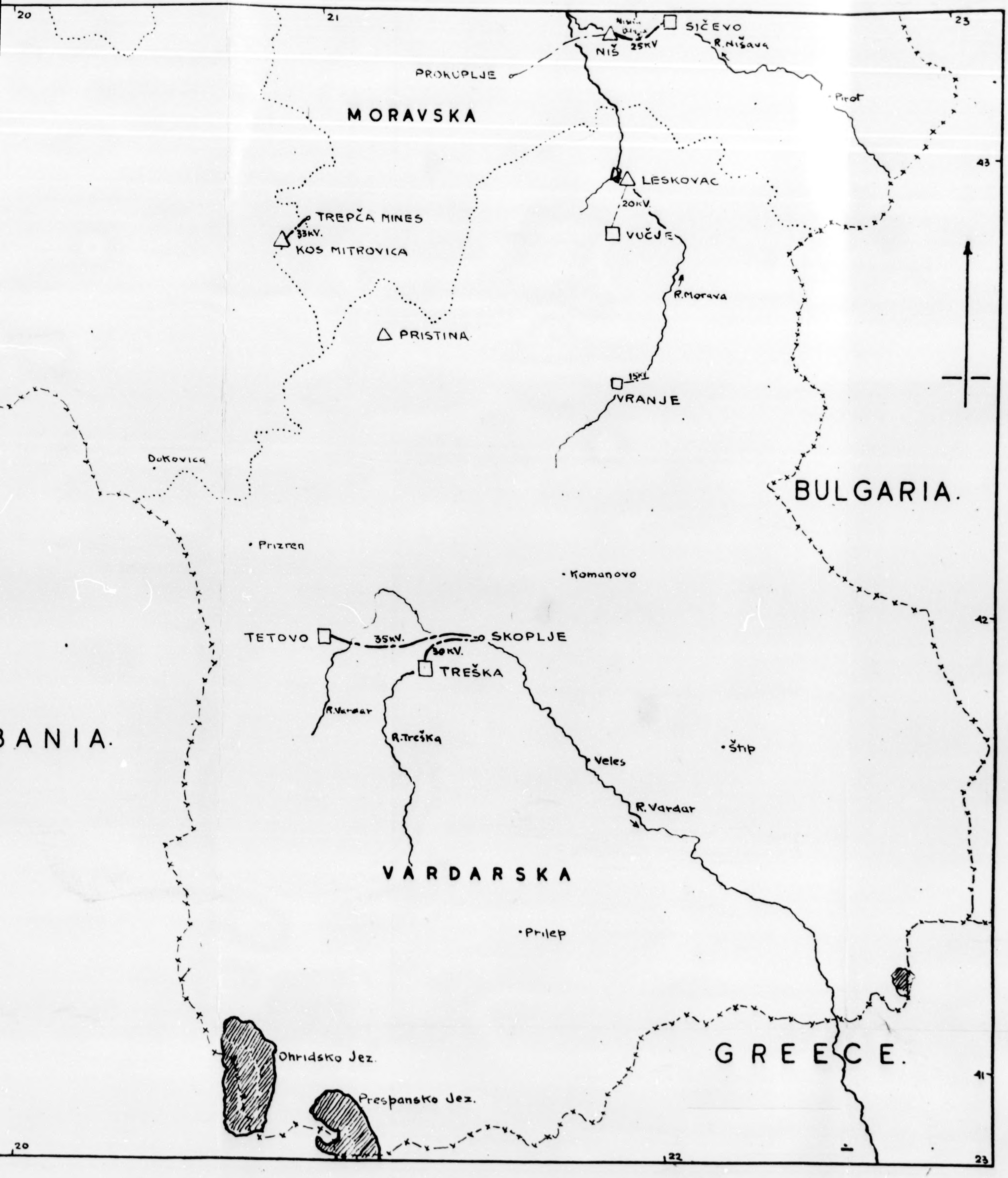
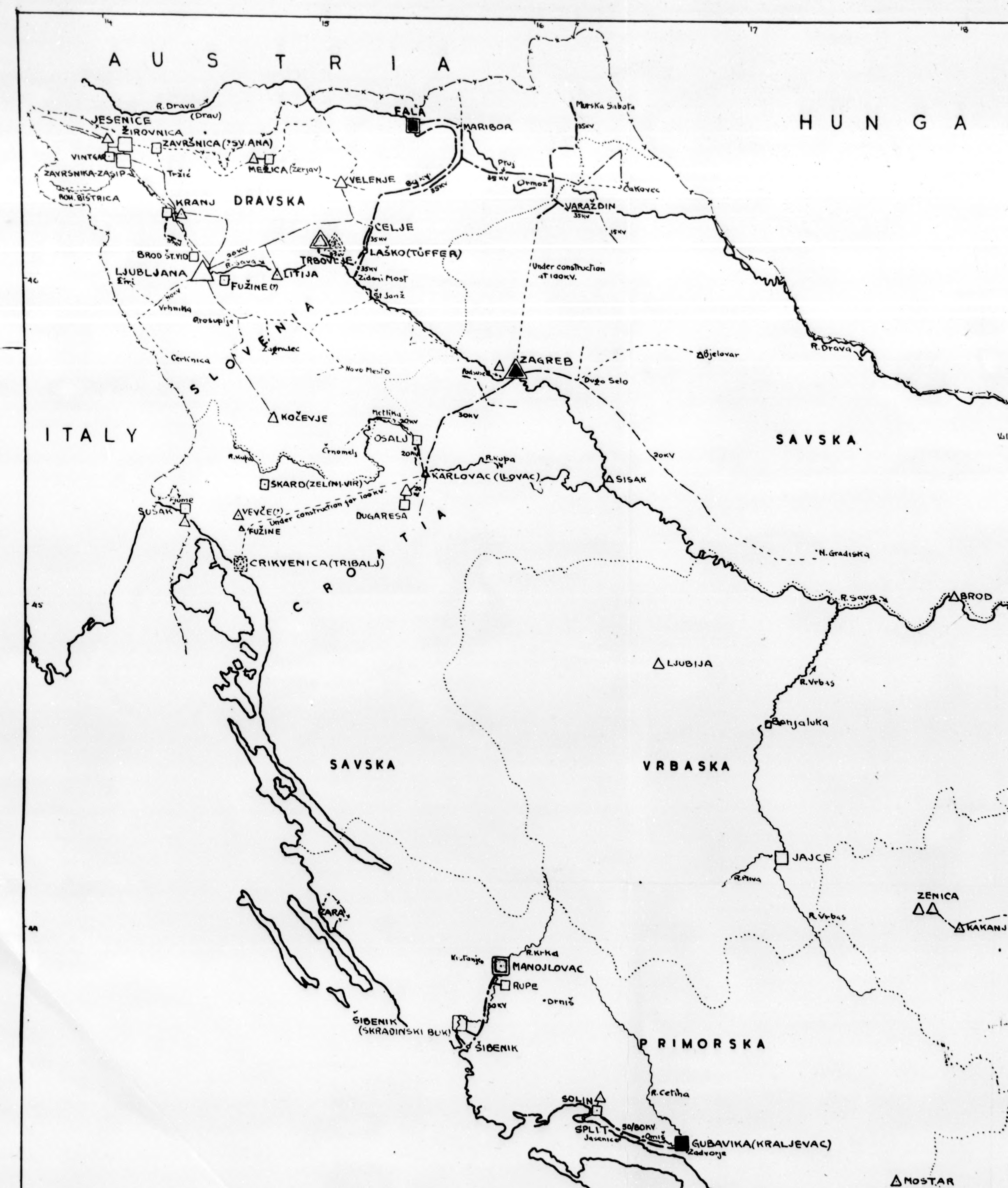
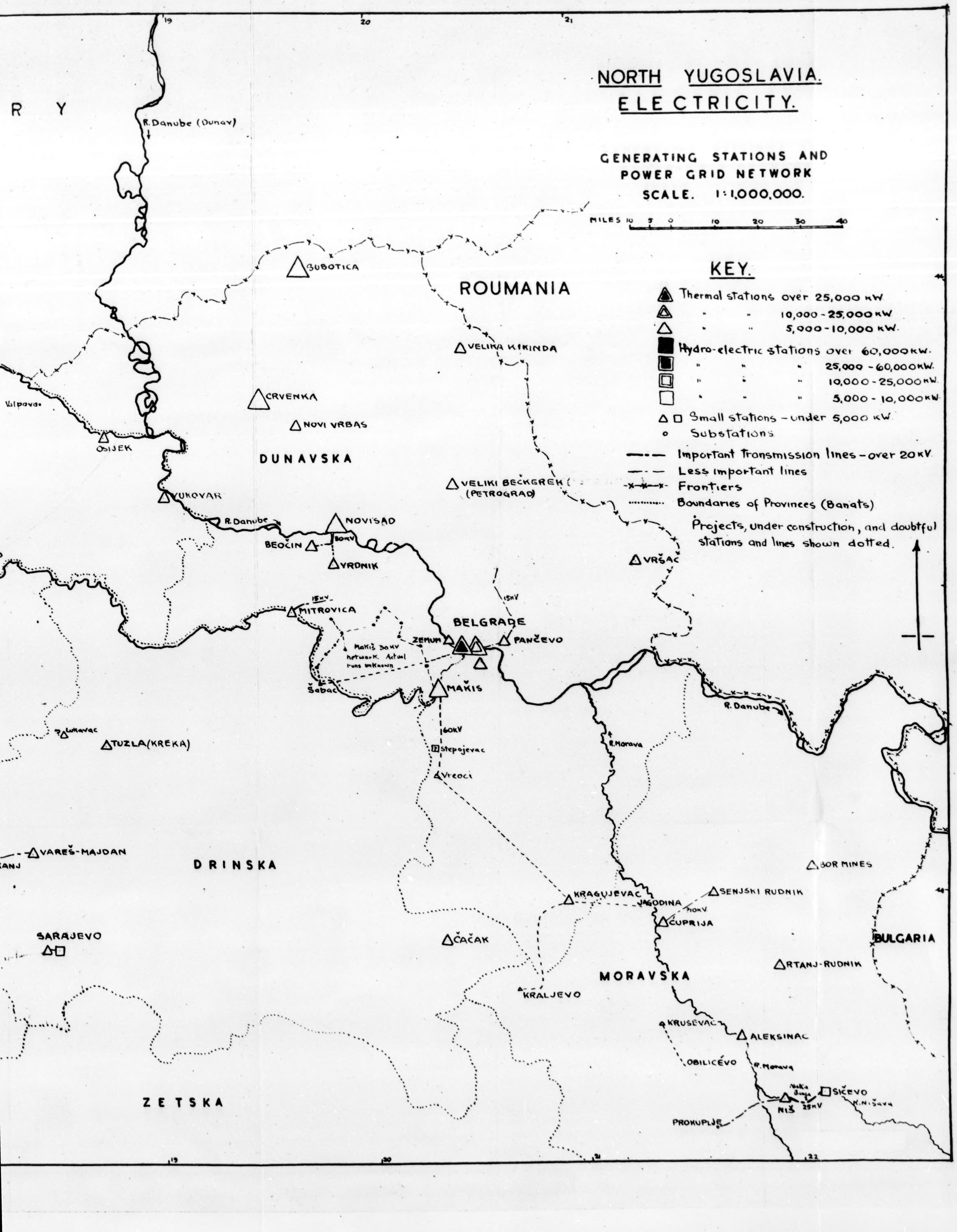
ZETSKA
43
DUBROVNIK
Podgorica
Cetinje
Skadarska Jez.
SOUTH YUGOSLAVIA
ELECTRICITY
GENERATING STATIONS AND
POWER GRID NETWORK
SCALE 1: 1,000,000
42
MILES 10 5 0 10 20 30 40
KEY.
△ Thermal stations 5,000 - 10,000 kW.
△ Small thermal stations
□ Hydro-electric stations 5,000 - 10,000 kW
□ Small hydro-electric stations
○ Substations
—·— Important transmission lines
—·— Less important lines
- - - - Doubtful lines
-x-x-x- Frontiers
.... Boundaries of Provinces (Banats)
ALB
←Bari
ITALY
M.I.10c. Jun.43.
18
19


20
21
23
22
43
42
41
NIŠ
25KV
SIČEVO
R. Nišava
PROKUPLJE
Pirot
MORAVSKA
LESKOVAC
20KV.
VUČJE
TREPČA MINES
33KV.
KOS MITROVICA
R. Morava
PRISTINA
15KV
VRANJE
Dokovica
BULGARIA.
Prizren
Komanovo
TETOVO
35KV.
SKOPLJE
30KV.
TREŠKA
R. Vardar
R. Treška
BANIA.
Veles
Štip
R. Vardar
VARDARSKA
Prilep
GREECE.
Ohridsko Jez.
Prespansko Jez.


AUSTRIA
HUNGA
ITALY
R. Drava (Drau)
JESENICE
ŽIROVNICA
ZAVRŠNICA (?SV. ANA)
VINTGAR
ZAVRŠNIKA-ZASIP
BOH. BISTRICA
Tržič
MEŽICA (Žerjav)
VELENJE
FALA
MARIBOR
Murska Sobota
Ptuj
Ormož
Čakovec
VARAŽDIN
KRANJ
DRAVSKA
CELJE
LAŠKO (TÜFFER)
TRBOVLJE
BROD ŠT. VID
LJUBLJANA
Šmi
LITIJA
FUŽINE (?)
R. Sava
Zidani Most
Št. Janž
Vrhnika
Grosuplje
Under construction at 100 KV.
SLOVENIA
Žužemberk
Cerknica
Novo Mesto
ZAGREB
Podsused
Bjelovar
Dugo Selo
KOČEVJE
Metlika
OSALJ
Črnomelj
R. Kupa
KARLOVAC (ILOVAC)
SISAK
SKARD (ZELINI-VIR)
DUGARESA
VEVČE (?)
FUŽINE
Under construction for 100 KV.
Fiume
SUŠAK
CRIKVENICA (TRIBALJ)
CROATIA
N. Gradiska
R. Drava
SAVSKA
R. Sava
BROD
LJUBIJA
R. Vrbas
Banjaluka
SAVSKA
VRBASKA
JAJCE
R. Pliva
R. Vrbas
ZENICA
KAKANJ
ZARA
Ki. Tonjo
R. Krka
MANOJLOVAC
RUPE
Drniš
ŠIBENIK (SKRADINSKI BUK)
ŠIBENIK
PRIMORSKA
R. Cetina
SOLIN
SPLIT
Jasenice
Omiš
GUBAVIKA (KRALJEVAC)
Zadvorje
MOSTAR
35 KV
30 KV
20 KV
50/80 KV
14
15
16
17
18
46
45
44
M.I 10c. Jun. 43.

DECLASSIFIED: Unless specifically marked, rem


NORTH YUGOSLAVIA.
ELECTRICITY.
GENERATING STATIONS AND
POWER GRID NETWORK
SCALE. 1:1,000,000.
MILES 10 5 0 10 20 30 40
KEY.
Thermal stations over 25,000 kW
" " 10,000-25,000 kW
" " 5,000-10,000 kW.
Hydro-electric stations over 60,000 kW.
" " " 25,000-60,000 kW.
" " " 10,000-25,000 kW.
" " " 5,000-10,000 kW.
Small stations - under 5,000 kW
Substations
Important Transmission lines - over 20 kV
Less important lines
Frontiers
Boundaries of Provinces (Banats)
Projects, under construction, and doubtful stations and lines shown dotted.
19
20
21
22
44
R Y
R. Danube (Dunav)
SUBOTICA
ROUMANIA
VELIKA KIKINDA
CRVENKA
NOVI VRBAS
Valpovo
OSIJEK
DUNAVSKA
VELIKI BEČKEREK (PETROGRAD)
VUKOVAR
R. Danube
NOVISAD
BEOČIN
30KV
VRDNIK
VRŠAC
15KV
15KV
MITROVICA
BELGRADE
ZEMUM
PANČEVO
Makiš 30KV network. Actual runs unknown
Šabac
MAKIŠ
R. Danube
60KV
Stepojevac
Vreoci
R. Morava
Lukavac
TUZLA (KREKA)
VAREŠ-MAJDAN
ANJ
DRINSKA
BOR MINES
KRAGUJEVAC
JAGODINA
SENJSKI RUDNIK
10KV
CUPRIJA
BULGARIA
SARAJEVO
ČAČAK
RTANJ-RUDNIK
MORAVSKA
KRALJEVO
KRUSEVAC
ALEKSINAC
OBILICÉVO
R. Morava
Niška Banja
SIČEVO
NIŠ
25KV
R. Nišava
PROKUPLJE
ZETSKA